

## THE BIOGEOGRAPHY AND ECOLOGY OF *EUPHYES DUKESI* (HESPERIIDAE) IN FLORIDA

JOHN V. CALHOUN<sup>1</sup>

1731 San Mateo Drive, Dunedin, Florida 34698, USA

**ABSTRACT.** A distinctive endemic phenotype of *Euphyes dukesi* (Lindsey) was first discovered in Florida in 1971. The endemic nature of Floridian populations was only recently recognized, and the populations currently remain undescribed. Pleistocene glacial events probably contributed to the isolation of these populations from populations on the North American mainland. The species has been found in at least five types of forested wetlands in Florida. The primary hostplant is *Rhynchospora inundata* (Oakes) Fern (Cyperaceae), but *Rhynchospora miliacea* (Lam.) A. Gray (Cyperaceae) and a species of *Carex* (Cyperaceae) also are utilized. *Euphyes dukesi* is bivoltine in Florida, with adults active primarily during May-June and September-October. Adults frequent sunlit patches of hostplants within swamps and visit a variety of nectar sources. The alteration and destruction of forested wetlands threaten populations of this species. *Euphyes dukesi* has a limited distribution and is considered rare in Florida.

**Additional key words:** endemic, swamps, hostplants, energy resources, behavior.

Since its description, Duke's skipper, *Euphyes dukesi* (Lindsey), has remained an enigmatic and poorly understood North American member of the genus *Euphyes*. This species generally is considered rare and known from only a few widely separated localities (e.g., MacNeill 1975, Pyle 1981, Opler & Krizek 1984). In Michigan, *E. dukesi* is a state-listed threatened species (Haack 1992). Owing to this perceived rarity, a number of distributional and ecological discoveries have been documented in detail (Pliske 1957, Mather 1963, 1966, Price & Shull 1969, Irwin 1969, 1972, Covell et al. 1979). The known range of *E. dukesi* extends from Virginia, southward along the Atlantic coast to Florida, west to southeastern Texas and northward in the Mississippi drainage to Indiana, Ohio, Michigan, and southern Ontario (Opler & Krizek 1984, Holmes et al. 1991, Stanford & Opler 1993) (Fig. 1). The species is represented in Florida by a recently recognized, but undescribed endemic subspecies (Shuey 1993). Throughout its range, this species is associated primarily with the interiors of swamps, habitats that characteristically support few butterfly species. Because of this extraordinary habitat affinity, *E. dukesi* remained undiscovered until 1922 (Lindsey 1923).

In common with most other North American members of the genus, *E. dukesi* has been recorded in association only with *Carex* (Cyperaceae) sedge hostplants (Shuey 1986). In the Great Lakes region, the only reported host is *Carex lacustris* Willd., a broad-leaved species fre-

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<sup>1</sup> Research Associate, Florida State Collection of Arthropods, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville, Florida.

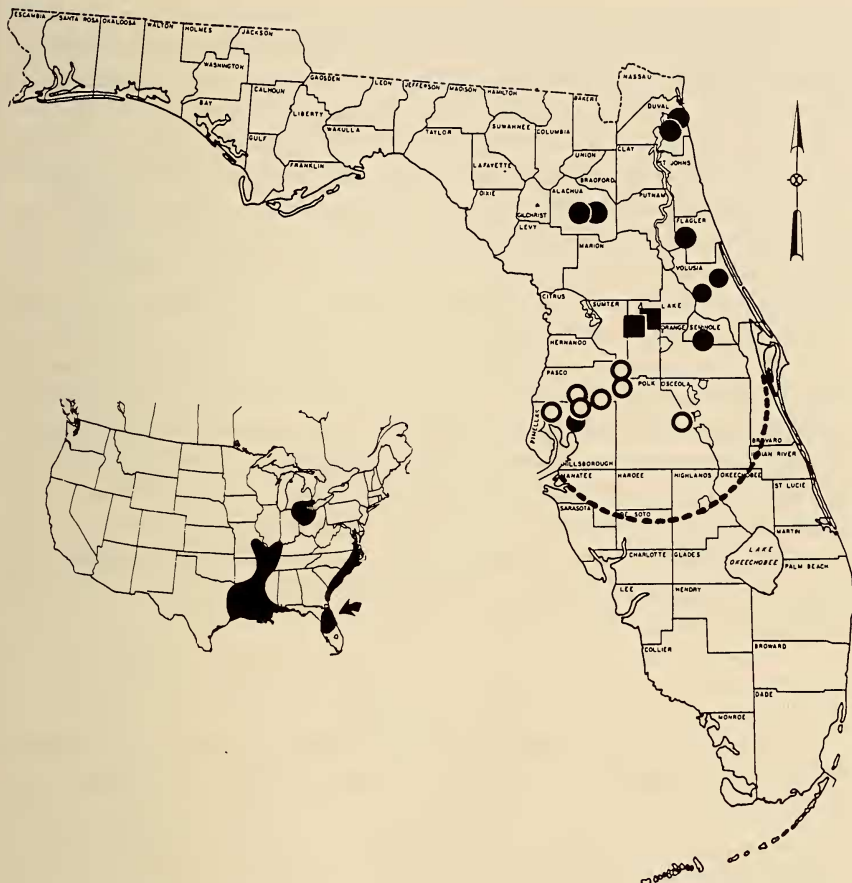


FIG. 1. Distribution of *E. dukesi* in Florida. Solid circles are historical records; open circles are populations located in central Florida 1990-1991; squares are populations discovered in 1992 by H. D. Baggett and M. C. Minno. The dotted line is the estimated southern range limit of the species. Inset map shows the generalized range of *E. dukesi* in North America (arrow indicates the range of the Floridian phenotype).

quently found within swamp forests and partially shaded drainage ditches (Pliske 1957, Shuey 1985, Iftner et al. 1992). In the Gulf States (e.g., Louisiana and Texas), *E. dukesi* has been found in association with *Carex hyalinolepis* Steud. (Irwin 1972) and *Carex lurida* Wallenb. (Rickard & Knudson 1980). *Carex lacustris* was once considered conspecific with *C. hyalinolepis* (= *C. lacustris* var. *laxiflora* Dewey). These species are very similar and it is possible that some Great Lakes populations of *E. dukesi* actually utilize *C. hyalinolepis*. The only other reported host is *Carex walteriana* Bailey which Scott (1986) listed with-

out reference. At least two additional *Carex* species are utilized in Texas (M. A. Rickard pers. comm.). Alternate common names for *E. dukesi* allude to these habitat and hostplant preferences (e.g. scarce swamp skipper [Pyle 1981] and brown sedge skipper [Scott 1986]).

For nearly twenty years following its original description, *E. dukesi* was known only from the type locality of Mobile, Alabama (Mather 1963). Although Holland (1931) predicted that *E. dukesi* would eventually be found "elsewhere along the Gulf," it was not until 1971 that the species was recorded in Florida. Until recently, the entire known Florida distribution of *E. dukesi* was limited to nine locations within six counties (Fig. 1). This species was considered very rare in Florida and records consisted of single or few individuals. In most cases, the species was encountered only once or twice at a given locality. Minno and Calhoun (in press) stress the need for surveys and ecological studies to properly determine the status of *E. dukesi* in Florida. Similar studies have led to the discovery of at least 30 populations in Ohio alone (Shuey 1985, Iftner et al. 1992). The purpose of this paper is to present the results of a detailed examination of the distribution, habitat, hostplants, and behavior of *E. dukesi* in Florida. Potential threats to Floridian populations also are identified.

#### BIOGEOGRAPHY

Shapiro (1971) remarked that *E. dukesi* possesses "the most extraordinary distribution of any North American butterfly," exhibiting a Coastal Plain-Great Lakes distribution pattern. He proposed that this pattern may be at least partially explained by the displacement of populations during Pleistocene glacial intervals, followed by the dispersal of the species through suitable vegetational corridors (e.g., the Mississippi and Mohawk Valleys) when the ice sheets retreated. Although Shapiro (1971) stated that *E. dukesi* is not phenotypically differentiated, the species does exhibit morphological differences to varying degrees (Mather 1963, Shuey 1994).

Remington (1968) observed that many plants and animals in peninsular Florida differ from their respective mainland populations. He identified a narrow zone of transition in northern Florida, across which little or no clinal trends exist. He attributed this to a combination of glacial and postglacial episodes, especially during the late Pleistocene. Shuey (1993) suspected that vegetational changes associated with glacial events contributed to the fragmentation and eventual divergence of peripheral populations of several species of *Euphyes*, including *E. dukesi*.

During Pleistocene glacial maxima, boreal forests penetrated far into

the southeastern United States (Webb 1990) and may have displaced populations of *E. dukesi* into refugia located in the Florida peninsula. During the Wisconsin glacial maxima (approx. 20,000 YBP), Florida's land area was much larger, extending outward to the edge of the continental shelf (Florida Plateau). At this time, swamps may have occupied bottomland and low-lying areas in northern Florida where mesic and riparian forests dominated (Webb 1990). The general climate of northern Florida appears to have remained relatively constant over the last 20,000 years (Platt & Schwartz 1990), suggesting that conditions were well suited for such refugia. Boreal forests may have acted as effective barriers, isolating populations of *E. dukesi* in Florida. Endemic populations of sand pine (*Pinus clausa* [Chapm. ex. Engelm.]) are believed to have been confined to Florida in this manner (Webb 1990). It is possible that populations of *E. dukesi* became isolated in Florida by a similar process during a glacial event prior to the Wisconsin. *Euphyes dukesi* has probably been present continuously in Florida many millennia longer than in the Great Lakes region where current populations could not have become established until after the Wisconsin glaciers had retreated (approx. 12,000 YBP). The species presumably populated present day forested wetlands during the last several thousand years in a manner consistent with island colonization.

*Euphyes dukesi* currently is found in Florida between the latitudes 30°20'N and 28°N, representing the southernmost populations of the species. Populations in Hillsborough County, Florida are located nearly 350 km further south than those in Texas and Alabama. Where *E. dukesi* occurs in Florida, average annual temperatures range from 18.9°C to 22.8°C (Fernald 1981). Many Florida populations are found within the Ocala Uplift physiographic district (Fig. 2) which is a highly diverse region with a relatively wide range of elevations and botanical communities (Brown et al. 1990). The remaining populations are found within the northern portion of the Eastern Flatwoods District (a low, flat region composed primarily of pine flatwoods communities), the Central Lake District (karst terrain with numerous lakes and sandhills) and the Sea Island District (pine flatwoods, dunes and salt marshes). The species probably occurs southward into the central portion of the Eastern Flatwoods District and the northern portion of the Southwestern Flatwoods District (another low, flat region dominated by pine flatwoods communities) (Figs. 1 & 2). A number of temperate species reach their southern range limit in this area (roughly 27°30'N), apparently due to decreasing habitat availability. *Euphyes dukesi* is undoubtedly absent from the Gold Coast-Florida Bay District of subtropical southern Florida. This district is low-lying and consists largely of marshes, dwarf cypress communities, and mangrove swamps (Brown et al. 1990). The

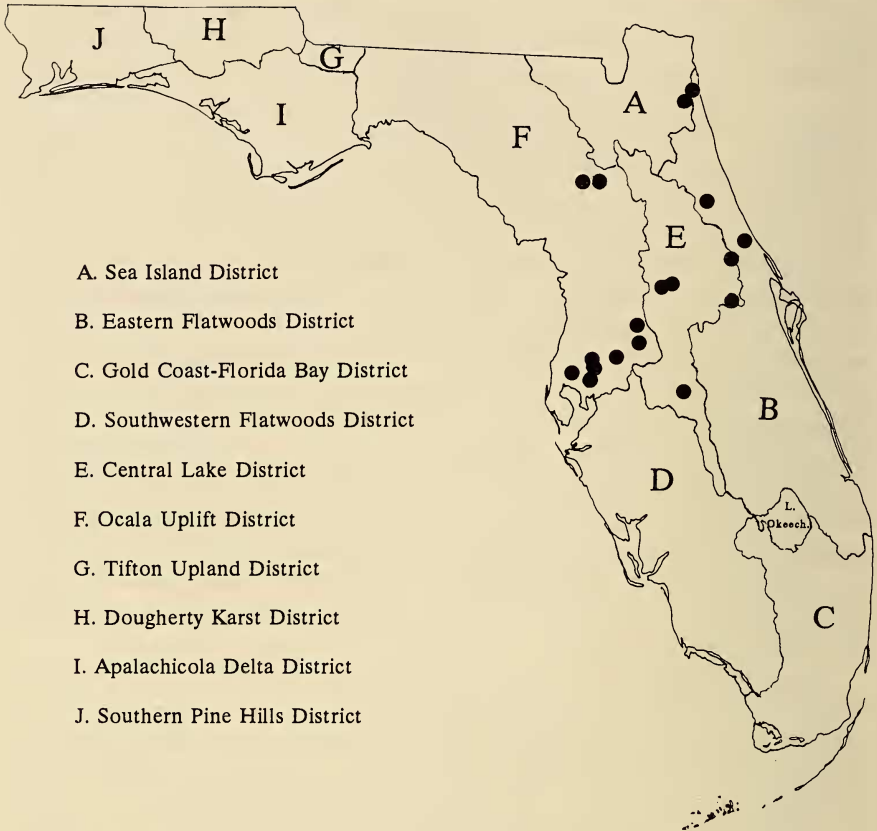


FIG. 2. Physiographic districts of Florida (adapted from Brown et al. 1990). Dots denote *E. dukesi* populations.

ecological characteristics of forested wetlands in this region differ from those elsewhere in the State.

Populations of *E. dukesi* almost certainly inhabit swamps within the various physiographic districts of the Florida panhandle. This portion of Florida lies only 48 km east of mainland *E. dukesi* populations in Alabama. As a result, populations of the mainland phenotype could inhabit the western counties of the Florida panhandle and intermediate populations may extend eastward. However, if sympatric populations of these subspecies are located, with no evidence of intergradation, their taxonomic relationship should be re-evaluated. Other butterflies that share the basic distribution pattern of *E. dukesi* in Florida include *Wallengrenia egeremet* (Scudder) (Hesperiidae), *Poanes zabulon* (Bois. & LeConte) (Hesperiidae), *Satyrium c. calanus* (Hübner) (Lycaenidae),

*Incisalia henrici margaretae* dos Passos (Lycaenidae), *Anthanassa texana seminole* (Skinner) (Nymphalidae), *Satyroides appalachia* (R. L. Chermock) (Satyridae), and *Cyllopsis gemma* (Hübner) (Satyridae). With the exception of *S. calanus*, these taxa are associated primarily with forested wetland habitats in Florida.

#### HABITAT

In August 1990, a large population of *E. dukesi* was discovered along a branch of the Big Cypress Swamp in southern Pasco County, Florida. The swamp is part of a forested wetland complex extending from central Pasco County southward into northern Hillsborough County. It supports an abundance of water ash (*Fraxinus caroliniana* Mill., Oleaceae), southern red maple (*Acer rubrum* var. *trilobum* K. Koch., Aceraceae), sweetgum (*Liquidambar styraciflua* L., Hamamelidaceae), water oak (*Quercus nigra* L., Fagaceae), cabbage palm (*Sabal palmetto* (Walt.) Lodd. ex Schultes, Arecaceae), and bald cypress (*Taxodium distichum* (L.) Rich., Taxodiaceae). Buttonbush (*Cephalanthus occidentalis* L., Rubiaceae) occurs locally throughout the swamp. Arrowroot (*Thalia geniculata* L., Marantaceae), dotted smartweed (*Polygonum punctatum* Elliot, Polygonaceae) and pickerelweed (*Pontederia cordata* L., Pontederiaceae) grow within many sunlit wet depressions. The swamp is seasonally flooded and becomes dry during the spring and autumn when precipitation levels are low. During the wet season (June–September), water levels may reach 0.5 m or more in the deeper depressions. It is within these water-filled depressions that *Rhynchospora* and *Carex* sedges form impressively large patches, sometimes dozens of square meters in size and consisting of thousands of individual plants. These sedge patches are common throughout the open understory where they grow to approximately 1 m in height and conceal many cypress aerial roots or “knees,” making travel through the swamp very treacherous (Figs. 3–4). *Euphyes dukesi* is found in close association with these sedges.

Based on this initial discovery, other forested wetlands in central Florida were surveyed in 1991 for *E. dukesi*. Swamps were selected that consisted of hardwoods with interior stands of cypress, suggesting that water levels were sufficient to support an abundance of sedges. Consequently, six additional populations of *E. dukesi* were found in Hillsborough, Pasco, Polk, and Sumter counties (Fig. 1).

Invertebrate diversity is high within swamps where *E. dukesi* occurs. Spiders are abundant, including *Nephila clavipes* (L.) (Araneidae), which constructs webs measuring 1 m or more in diameter. Large mosquitoes of the genus *Aedes* (Culicidae) are particularly troublesome. Dragonflies, such as *Epiaeschna heros* (Fab.) (Aeshnidae), patrol sunlit clear-

ings. Species of Lepidoptera inhabiting swamps with *E. dukesi* include *Callosamia securifera* (Massen) (Saturniidae), *Catocala* spp. (Noctuidae), *Oligoria maculata* (W. H. Edwards) (Hesperiidae), *Problema byssus* (W. H. Edwards) (Hesperiidae), *Wallengrenia egeremet*, *Hermemythia sosybius* (Fab.) (Satyridae), *C. gemma* and *S. appalachia*. *Calpododes ethlius* (Stoll) (Hesperiidae) frequents sunlit patches of its hostplant (*T. giniculata*) and *Papilio glaucus* (L.) (Papilionidae) is a common canopy species in many swamps dominated by hardwoods. Species of sedge moths (Glyphipterigidae) undoubtedly occur in these swamps as well. A number of vertebrates also occupy these habitats. The eastern diamondback rattlesnake (*Crotalus adamanteus* Beauvois, Viperidae) and Florida cottonmouth (*Agkistrodon piscivorus conanti* Gloyd, Viperidae) are occasionally encountered. Many species of migrating songbirds utilize the swamps as important food sources.

Freshwater forested wetlands, or swamps, can be defined as ecosystems that support trees where soils are periodically flooded or saturated by fresh water for significant periods of time during the life cycle of the trees (Lugo 1984). These ecosystems comprise ten percent of Florida's land area (Ewel 1990) and have been classified by a variety of methods (e.g., Penfound 1952, Cowardin et al. 1979). Wharton et al. (1977) classified Florida swamps into 26 types, but *E. dukesi* has been found in association with only a few of these. Many *E. dukesi* populations in Florida are found in blackwater creek swamps (blackwater floodplain forests). These swamps occupy the floodplains of streams, are dominated by bottomland hardwoods, and are seasonally flooded (Wharton et al. 1977). The population of *E. dukesi* in southern Pasco County (the largest known population in Florida) occurs in a swamp that can loosely be defined as a mixed hardwood swamp (K. C. Ewel pers. comm.). A similar nearby swamp has been characterized as a mixed hardwood bald cypress forest (Rochow 1983) and a mixed-hardwood and cypress floodplain (Rochow 1985). The wetter portion of the swamp is floristically comparable to blackwater creek swamps but no distinct stream channel is present. The upper zones of the swamp are similar to hydric hammock subsystems in which oaks (*Quercus* spp.) and cabbage palmetto (*S. palmetto*) predominate.

Smaller populations of *E. dukesi* have been found in association with stillwater swamps. Most of these swamps are seasonally flooded and derive water from rainwater and shallow ground water (Wharton et al. 1977, Ewel 1990). A small number of *E. dukesi*, including larvae and pupae, have recently been found in association with *R. inundata* in stillwater lake fringe swamps of north-central Florida (M. C. Minno pers. comm.). These swamps are found adjacent to lakes, are dominated by bald cypress, and have fluctuating water levels (Wharton et al. 1977). *Euphyes dukesi* has rarely been found in stillwater swamps that possess

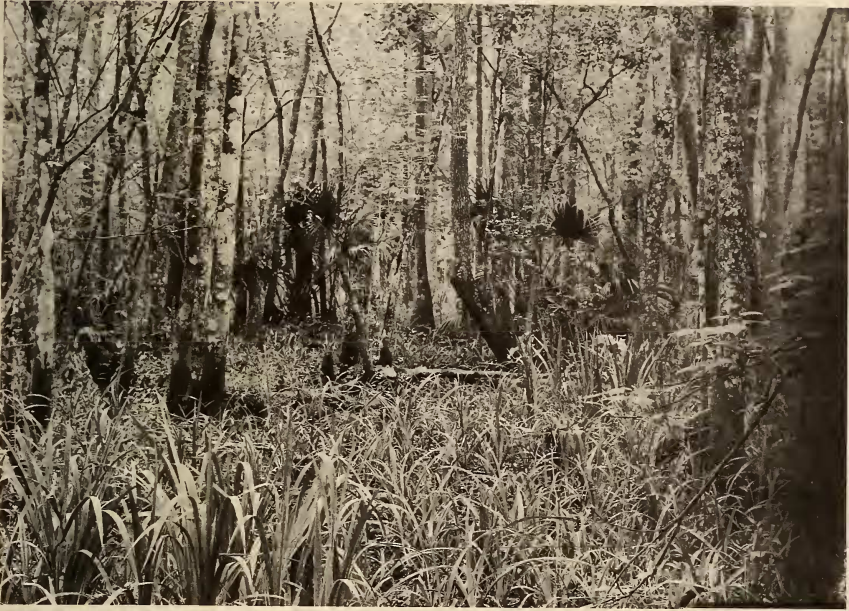


FIG. 3. Habitat of *E. dukesi* near Cypress Creek Swamp, Pasco Co., FL (note extensive understory of sedges).

an upperstory consisting almost entirely of bald cypress. Many cypress swamps contain deep water interiors, restricting sedges to small clumps on raised areas (such as around tree bases). Other such swamps are very dense, without sedge understories, or are more open and provide insufficient shade for *E. dukesi*.

One male and one female *E. dukesi* were found at the edge of a bay swamp (bayhead) in eastern Polk County. Stillwater bay swamps are dominated by bay trees [*Persea* spp., Lauraceae; *Gordonia lasianthus* (L.) Ellis, Theaceae; and *Magnolia virginiana* L., Magnoliaceae] and are constantly wet (Wharton et al. 1977). These swamps are usually very dense and provide little habitat for *E. dukesi*. However, the sedges at the collection site grow along the sunlit margin of the swamp and *E. dukesi* was flying where little shade is available. This atypical open habitat is reminiscent of a Louisiana population of *E. dukesi* discussed by Irwin (1972) and some other populations in the lower Mississippi drainage.

Using the classification of Cowardin et al. (1979), all Florida swamps in which *E. dukesi* is known to occur can be described as of the Palustrine System, Forested Wetland Class, and of the Subclasses Broad-leaved Deciduous (mixed hardwood swamps and creek swamps), Narrow-leaved Deciduous (cypress swamps and lake fringe swamps), and



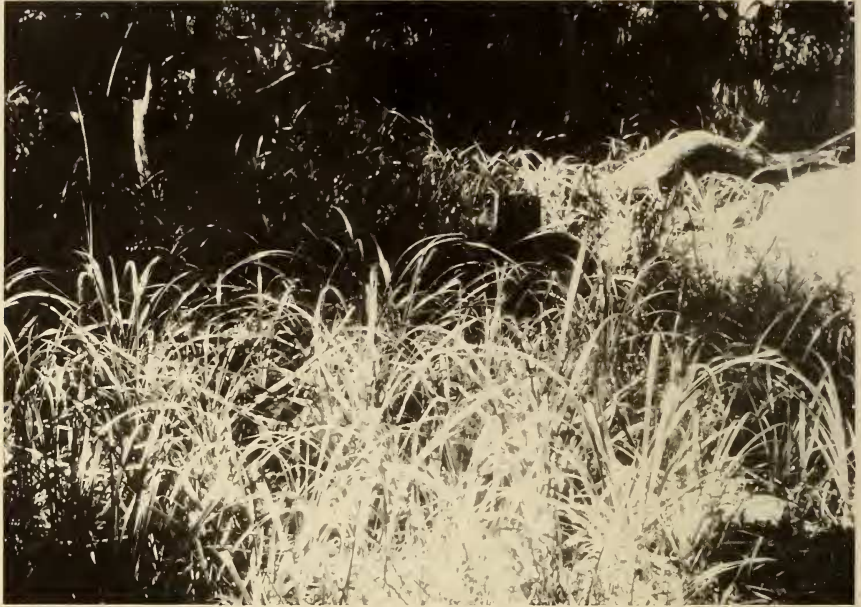


FIG. 4. Sunlit patch of *R. inundata* growing in the interior of a mixed hardwood swamp (Pasco Co., FL).

Broad-leaved Evergreen (bay swamps). *E. dukesi* will undoubtedly be discovered in other types of swamps as well.

Based on these habitat observations, as well as observations of adult energy resources and behavior described below, "appropriate" swamp habitat for *E. dukesi* in Florida exhibits four basic characteristics: (1) an upperstory usually dominated by broadleaf deciduous trees, (2) a broken canopy allowing scattered sunlight penetration into the interior of the swamp, (3) an open understory with an abundance of sedges (ideally, some patches of sedges are sunlit for several hours each day), and (4) the presence of sunlit nectar sources within the interior of the swamp and/or directly adjacent to the exterior of the swamp (these flowers must be available during the months when *E. dukesi* adults are expected to occur). In addition, large swamps, and swamps that are located near other similar swamps, are more likely to support populations of *E. dukesi* than swamps that are small and isolated.

#### HOSTPLANTS

Throughout Florida, *E. dukesi* populations are associated primarily with beaked-rush sedge, *Rhynchospora inundata* (Oakes) Fern (Cy-

peraceae), rather than *Carex* sedges as expected. In 1990, several waxy pupae and pupal exuviae of *E. dukesi* were found in loose silken shelters on *R. inundata* in Pasco County. Although *R. inundata* is apparently the primary host, pupae were also found on *Rhynchospora miliacea* (Lam.) A. Gray (Cyperaceae) and a species of *Carex*. Furthermore, females were observed ovipositing on *R. inundata* and *R. miliacea*. These *Rhynchospora* hostplants are widespread and common throughout Florida (Gale 1944, Wunderlin 1982, Clewell 1985, Dressler et al. 1987).

Although the *Carex* utilized by *E. dukesi* in Florida remains unidentified, it is probably *C. lupulina* Muhl. ex. Schkuhr. (Cyperaceae) which is widespread at the site. Larvae produced by *E. dukesi* females captured at the site were lab reared on *C. lupulina* (M. C. Minno pers. comm.). *Rhynchospora miliacea* and *C. lupulina* grow throughout the swamp, but in smaller clumps and less abundantly than *R. inundata*. This is the first time that *E. dukesi* has been known to utilize more than one hostplant at a single location. In central Florida, *E. dukesi* has been seen ovipositing single ova near the midrib on the upperside of sedge blades. This is contrary to the observations of Pliske (1957) who noted oviposition on the underside of blades in Michigan populations.

All seven reported hostplants of *E. dukesi* are found throughout much of the eastern United States and may be fed upon in many areas. *Carex lacustris* is the only host not known to occur in Florida (Godfrey & Wooten 1979). At least 39 species of *Rhynchospora* and 52 species of *Carex* are found in the southeastern United States (Godfrey & Wooten 1979) and it is likely that *E. dukesi* exploits a number of additional sedges. *Euphyes dukesi* does not appear to be restricted to broad-leaved sedges. Blade widths of known hosts range from as little as 2–5 mm (*C. walteriana*) to 1 cm (*Rhynchospora* spp.).

*Rhynchospora inundata* also serves as a hostplant of *S. appalachia* in many Florida swamps (Brown 1973). Both *E. dukesi* and *S. appalachia* are swamp-dwelling sedge feeders and have been recorded in many of the same forested wetlands throughout their ranges, including Florida. However, *S. appalachia* is more widespread and apparently enjoys a broader range of ecological requirements than *E. dukesi*. In Florida, *S. appalachia* is found in a number of swamps where *E. dukesi* is not known to occur.

It is also notable that *Arotis derasa* (Herrich-Schäffer) (Hesperiidae), a closely related Brazilian species formerly considered a member of *Euphyes*, also occurs in forested habitats and utilizes *Rhynchospora* as a hostplant (Mielke 1972). *Arotis* is probably a sister genus to *Euphyes* (Shuey 1987) and the similarity of habitats and hostplants may be due to "shared" ancestral ecological requirements (J. A. Shuey pers. comm.).

## PHENOLOGY

Great Lakes populations of *E. dukesi* are univoltine, with adults flying primarily from late June through mid-August (Shull 1987, Holmes et al. 1991, Iftner et al. 1992). From Kentucky and Virginia southward, *E. dukesi* is bivoltine, flying primarily from mid-May through June and mid-August through early October (Covell et al. 1979, Nielsen 1982, Opler & Krizek 1984). Despite the comments by several authors (e.g., Opler & Krizek 1984, Scott 1986, Opler & Malikul 1992) that *E. dukesi* probably produces three broods in the extreme southern portion of its range, historical capture dates in Florida suggested only two broods. Extreme dates for each brood were 29 May (1979)–6 June (1979) and 14 September (1977)–8 October (1978). Only one record fell outside these dates; a single specimen (the first from Florida), collected in July 1971.

The population of *E. dukesi* in southern Pasco County was studied to determine the total number of broods and length of each flight period. Adults emerge nearly simultaneously and can become common within two or three days. In 1991, the first freshly emerged adults were observed on 11 May and the species was encountered at the site on a weekly basis until 8 June when only several worn females were found. None were observed on 30 April or 15 June, thus the first brood flight period lasted for approximately one month. The timing of the first brood can vary, apparently due to differences in precipitation. In 1993, when spring precipitation levels were below that of 1991, adults were not observed until 21 May and were still present after 16 June. Extreme dates for the first brood at this site are 9 May(1992)–16 June(1993). The second brood is comparable in length; extreme dates at this site (not including a single unusual record from 18 August 1990) are 13 September(1990)–13 October(1990). There is no evidence of a third brood in Florida (Fig. 5). The species is probably bivoltine in Texas as well, but the broods appear to be extended (M. A. Rickard pers. comm.). B. Mather (pers. comm.) suspected that capture dates in Mississippi “meant more than two broods—or if only two then rather long flight periods.” Most other members of the genus *Euphyes*, including *E. dion* (W. H. Edwards), *E. bayensis* Shuey, *E. berryi* (Bell), and *E. bimacula* (Grote & Robinson), are generally believed to be bivoltine in the Deep South (Opler & Malikul 1992). Like these congeners, *E. dukesi* probably does not produce three broods anywhere within its range. Records that allude to a third brood are probably referable to the anomalous emergence of first and second brood individuals, extended flight periods and/or differences in brood timing between populations. Although adults of *E. dukesi* may potentially be encountered in Florida over a six month

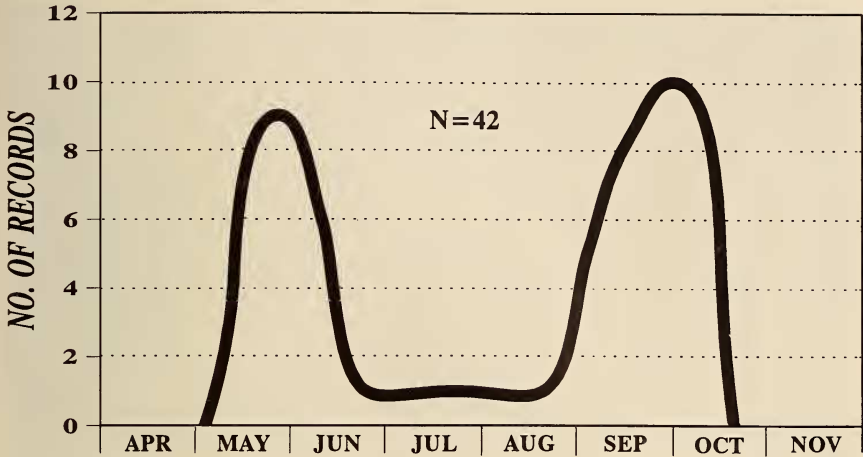


FIG. 5. Temporal distribution of *E. dukesi* in Florida (based on data from 1971–1993; record-any number of adults captured at a given locality on a given day).

period, they should be expected only during a month in spring and again during a month in autumn. The flight periods roughly coincide with the onset and termination of the wet-season.

#### ADULT BEHAVIOR

Most habitat descriptions for *E. dukesi* are inaccurate and misleading, often given simply as “shaded swamps.” Clark and Clark (1951) stated that the species is found in deep swamps, “seldom venturing out of the shade.” Opler and Krizek (1984) also remarked that *E. dukesi* is “found in the shade of wooded swamps.” However, adults are rarely encountered in densely shaded portions of swamps. Rather, they are most often observed around patches of hostplants that are at least partially sunlit. This is true in the Great Lakes region as well as in Florida (pers. observation, see habitat photo in Iftner et al. 1992; plate 4, row 3).

The dark ground color, contrasting wing surfaces and bobbing flight combine to give Floridian *E. dukesi* the appearance of giant *Ancyloxypha numitor* (Fab.) (Hesperiidae) or large, swamp-inhabiting *Poanes massasoit* (Scudder) (Hesperiidae). Adults usually fly just above the sedges, rarely exceeding 1.5 m in height. Males patrol through and around the sedges in search of females, but do not appear to be territorial. When males encounter one another, they quickly resume patrolling without altercation. If receptive females are not located within a patch of sedge, patrolling males will rapidly fly to another patch and continue their search. Females are less active than males and usually must be flushed from the sedges unless they are visiting nectar sources



FIG. 6. Female *E. dukesi* resting among shaded *R. inundata* blades.

or ovipositing. When ovipositing, females concentrate activity around sedge plants growing singly or in small clumps along the more shaded perimeter of sedge patches (Fig. 6). Both sexes have been seen flying through adjacent upland forests, and one female was observed visiting flowers along the edge of a large pasture over one hundred m from the nearest swamp. Females probably disperse widely in search of hostplants and may rapidly colonize nearby swamps when hostplants become available. Adults are most active within the humid interior of swamps when the weather is warm and sunny. However, as with many other swamp or forest inhabiting Lepidoptera, they also are active in warm overcast weather, even during brief thunder showers. Both sexes of *E. dukesi* have been observed dorsal basking (Fig. 7) on dew-laden sedge leaves as early as 0800 h (EDT) (when sunlight first begins to penetrate the wooded habitat). Under optimum weather conditions adults become active by 0830 h and may continue to fly or remain at sunlit nectar sources until roughly 1800 h.

#### ADULT ENERGY RESOURCES

There is typically a lack of flowers growing in swamp environments, thus few adult energy resources have been documented for *E. dukesi*



FIG. 7. Male *E. dukesi* dorsal basking on sunlit sedge blade.

(see Opler & Krizek 1984, Iftner et al. 1992). Frequently visited nectar sources are sunlit, including those of the interior of swamps. In central Florida, adults of the first brood have been observed visiting *C. occidentalis*, *P. cordata*, and *Cirsium* sp. (Asteraceae). Those of the second brood visit *P. cordata*, *P. punctatum*, and *Bidens alba* (L.) DC. (Asteraceae). All known nectar sources in Florida are white or purple. This color preference has also been noted in Ohio (Iftner et al. 1992). *Cirsium* sp. and *B. alba* occur outside the swamp environment and attract *E. dukesi* into more open habitats. Nectar source visitation in open situations also has been observed in Great Lakes populations (Price 1970, Shuey 1985, Iftner et al. 1992). Closely related Neotropical species of *Arotis* also leave their forested habitats to obtain nectar (Mielke 1972).

Individuals of *E. dukesi* visit flowers that occur from near ground level (*B. alba*) to at least 2.5 m in height (*C. occidentalis*). Adults are quite docile when feeding and often can be approached closely or even touched. When feeding, they do not engage in sexual behavior. Males and females have been observed simultaneously visiting the same blooms of *P. cordata* and *C. occidentalis* without interaction.

#### THREATS AND STATUS IN FLORIDA

It is unlikely that avocational collecting could negatively impact populations of *E. dukesi*. There is a general bias by most lepidopterists

against entering wet, mosquito-infested environments. As Niering (1985) aptly stated, these habitats are often viewed as "dark, mysterious, forbidding places, to be avoided at all costs." This undoubtedly has contributed to the enigmatic reputation of *E. dukesi*. This species is very localized and often inhabits only a small area within a given swamp, increasing the likelihood that a population will be overlooked. In addition, there is little or no commercial value associated with this species. By far, the most serious threats to *E. dukesi* in Florida are the alteration and destruction of forested wetlands.

Since the late eighteenth century, Florida has lost over half of its wetlands, mostly through conversion to agriculture and development. In only ten years, between the mid-1970's and mid-1980's, over 640,000 ha of wetlands were destroyed (Yokel 1992). For example, construction of Rodman Reservoir (Oklawaha Lake) in Putnam County resulted in the elimination of nearly 4000 ha of floodplain forest along the Oklawaha River (Lugo & Brown 1984). Although laws currently exist to conserve and manage wetlands in Florida, they have been inadequately implemented and enforced (Yokel 1992). At least one population of *E. dukesi* in Florida is thought to have been extirpated as a direct result of the destruction of swamp habitat. The fragmentation and isolation of remaining forested wetlands can greatly reduce the ability of female *E. dukesi* to locate other swamps and establish new populations.

The direct destruction of forested wetlands is not the only danger to populations of *E. dukesi* in Florida. The cutting of a large number of bald cypress or other trees from a swamp could lead to a pronounced increase in sunlight penetration and the possible elimination of a local *E. dukesi* population. The drainage of swamps can result in the loss of sedges necessary to support populations of *E. dukesi*. Rochow (1985) provided evidence that intensive deep underground water pumping also may adversely affect nearby forested wetland vegetation. Such pumping in the Cypress Creek Well Field in central Pasco County (near a large population of *E. dukesi*) appears to have lowered the water table and resulted in a drastic reduction in the amount of *R. inundata* and *R. miliacea* over a five year period (Rochow 1983). The channelization of streams can also lower the water table and similarly eliminate sedges from associated floodplain swamps. Road construction through floodplain swamps can effectively prevent natural drainage, thereby raising water levels and flooding out populations of sedges (Wharton et al. 1977). Populations of *E. dukesi* also could disappear due to extended natural drought or flooding conditions. The ecological characteristics of forested wetlands are largely determined by hydroperiod (length of time the soils are annually saturated) (Ewel 1990). Therefore, any changes in the fluctuation of water within a swamp could potentially alter the habitat beyond the threshold of acceptability to *E. dukesi*.

Despite these risks, some Florida populations of *E. dukesi* are relatively secure. Several populations occur in the Green Swamp of central Florida. This region encompasses 2234 km<sup>2</sup> and serves as the headwaters of five rivers. Approximately 80 percent of this total wetland area is forested (Brown 1984). The Green Swamp is one of Florida's most important groundwater recharge areas and is managed by the State of Florida as an Area of Critical Concern. Many forested wetlands in this region serve as important nesting areas for wading birds. Loss of wetland habitats in this region will probably be minimal.

Swamp habitats support a number of rare and poorly known organisms in Florida. The vulnerability of these ecosystems underscores the urgency in understanding these species. Because of the strict ecological requirements and limited number of known *E. dukesi* populations in Florida, the endemic peninsular phenotype is still considered rare, despite the discovery of additional populations (Minno & Calhoun in press). Many habitats that appear acceptable have not yielded *E. dukesi*, emphasizing our incomplete understanding of the ecological requirements of this species. Appropriate swamp habitats should be examined for the presence of *E. dukesi*. Known populations should be closely monitored and, if necessary, managed to ensure the continued survival of this interesting Florida wetland inhabitant.

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